Modeling Student Understanding of Period, Frequency, and Angular Frequency

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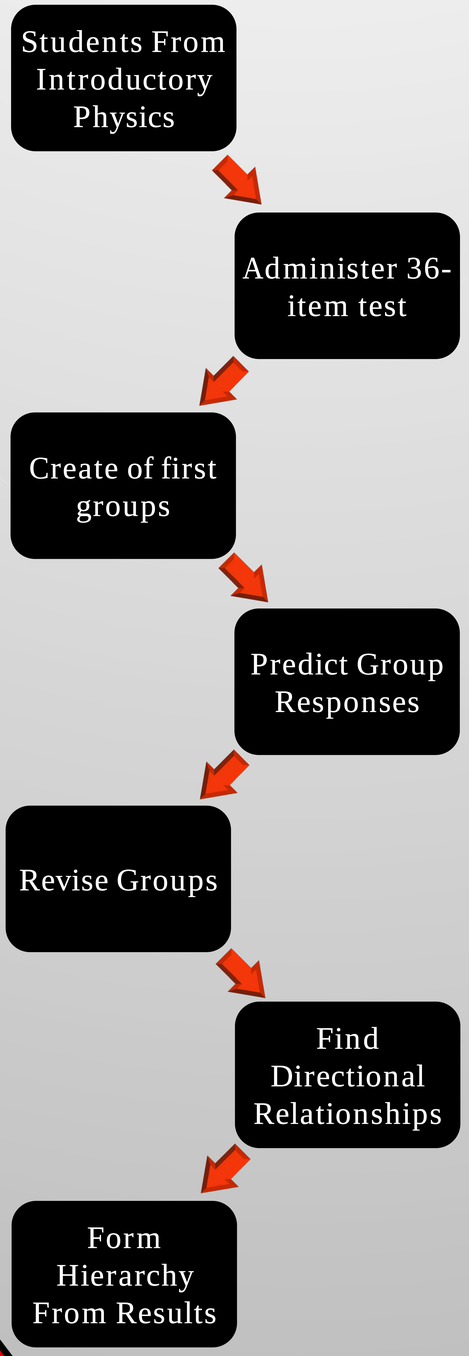
Introduction

- Determining and understanding period, frequency, and angular frequency are essential skills and concepts in physics.
- Multiple representations are an important operational way of measuring skills and "understanding."
- We previously found students have difficulty extracting information from graphical representations and have difficulty performing calculations involving the period (T), frequency (f), and angular frequency (ω).
- **Goal: Classify student understanding according to the skills they have mastered and search for possible hierarchies in their knowledge.**

Methodology/Results

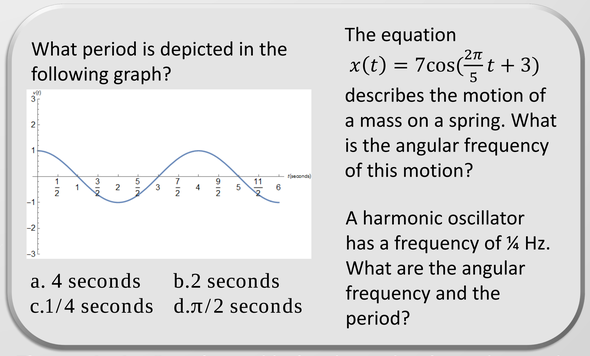


		ω=2πf	
		No	Yes
T=1/f	No	16	0
	Yes	22	19

		ω=2π/T	
		No	Yes
T=1/f	No	15	1
	Yes	21	20

		ω=2πf	
		No	Yes
ω=2π/T	No	36	0
	Yes	2	19

Tables 1a, b, c: The number of students having mastered using the indicated equation (no is not mastered, yes is mastered).



Figures 1a-1c: Sample graphical and equational questions and a sample calculation from the 36-item test.

	Graphical Questions					
	Period		Frequency		Angular Frequency	
Group	P	A	P	A	P	A
3 eqns	?	100%	✓	95%	✓	95%
1 eqn	?	95%	✓	**71%**	×	14%
0 eqns	?	87%	×	7%	×	7%

	Equational Questions					
	Angular Frequency		Period		Frequency	
Group	P	A	P	A	P	A
3 eqns	?	**79%**	✓	84%	✓	84%
1 eqn	?	19%	×	10%	×	5%
0 eqns	?	27%	×	7%	×	0%

Tables 2a and 2b: Predicted (P) and actual (A) skills mastered by each group, where actual is the percent of students mastering the skill. A question mark signifies no prediction can be made from model.

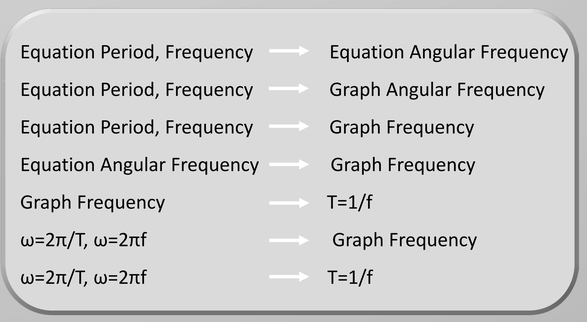


Figure 2: Statistically significant relationships between mastered skills.

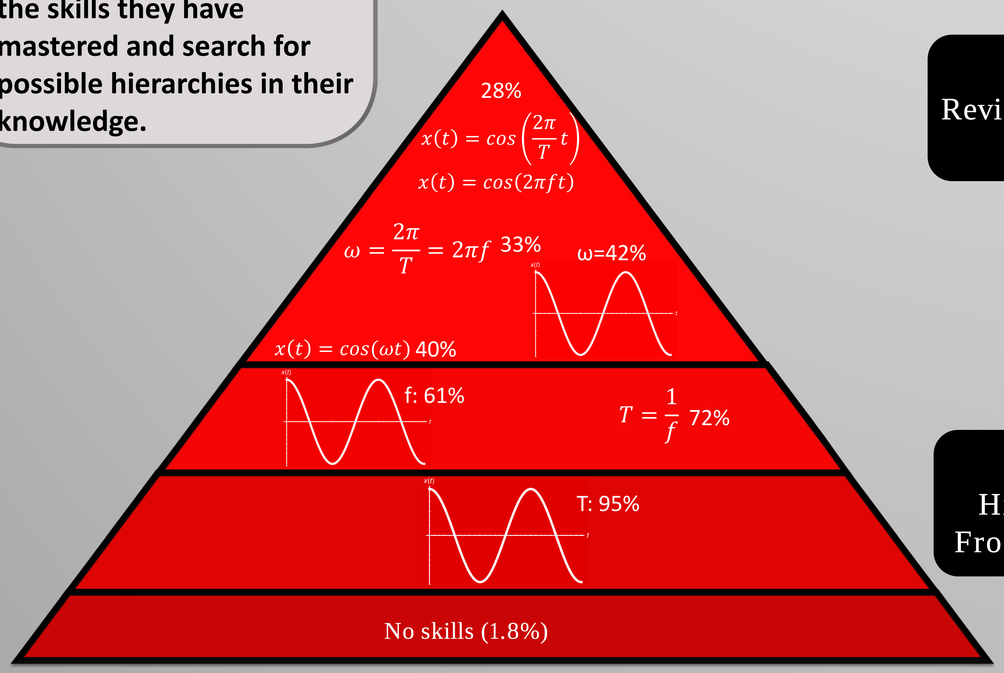


Figure 3: Hierarchy of skills related to determining the period, frequency, and angular frequency. Percent is the percentage of students having mastered the skill.

Conclusions

- **Student understanding of the period, frequency, and angular frequency can be modeled as a three-level hierarchy.**
- Less than half of the students at the top level, indicating a need for essential skills training.
- Understanding the period and frequency relationship is a prerequisite to understanding any relationship involving the angular frequency.
- Strong correlation between score on calculation questions and scores on graphical and equational questions

Future Research

- Determine if students in introductory-algebra-based physics courses also display this hierarchical knowledge structure.
- Modify our Essential Skills platform to ensure that students master the period and frequency relationship before attempting to master any skill involving the angular frequency.

Acknowledgements

I would like to thank Nathaniel Amos, Ryan Badeau, Abby Bogdan, and Daniel White for their assistance and feedback throughout this project.